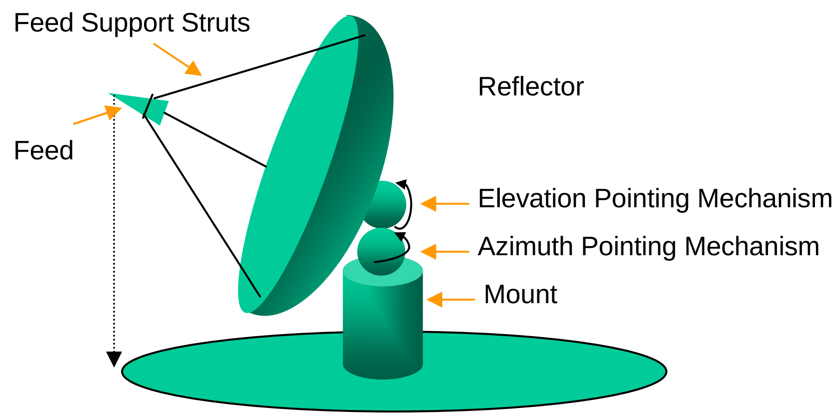
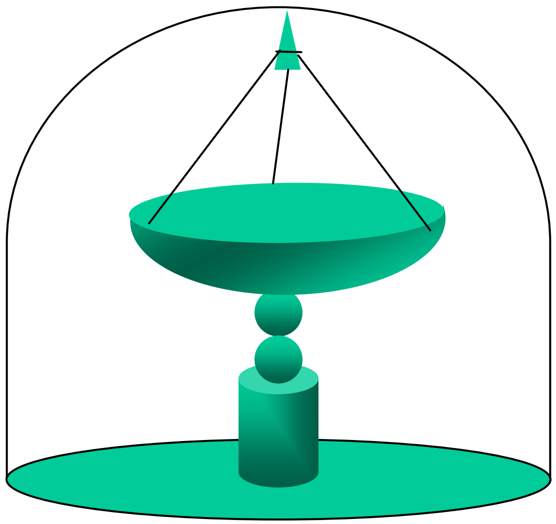
Conventional Approach
Uses a Gimbaled Reflector Antenna

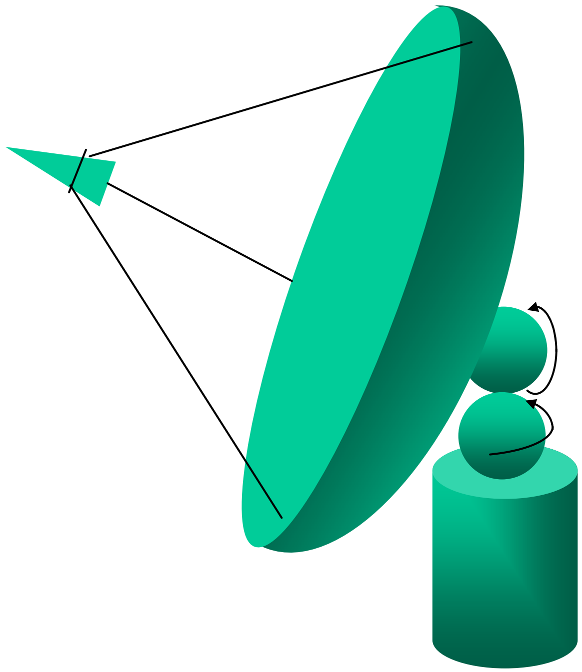
- **System Requirement**
  - **Pencil Beam with high gain, requires reflector with diameter, D**
    - **F/D Ratio likely to be ~0.8**
  - **Geometry allows for full hemispherical coverage**
    - **Two axis gimbal**
- **Derived Requirement**
  - **Center Height must be at least 0.5 D in order to point to the horizon**
  - **Swept Volume is significantly larger than reflector diameter**
    - **Base diameter accommodates focal length, feed length (or subreflector, if used), and width of pointing mechanisms**
    - **~2*D base diameter**
      - **Little over 2m base diameter**





Impacts From Incorporating Two-Axis Pointing Mechanism

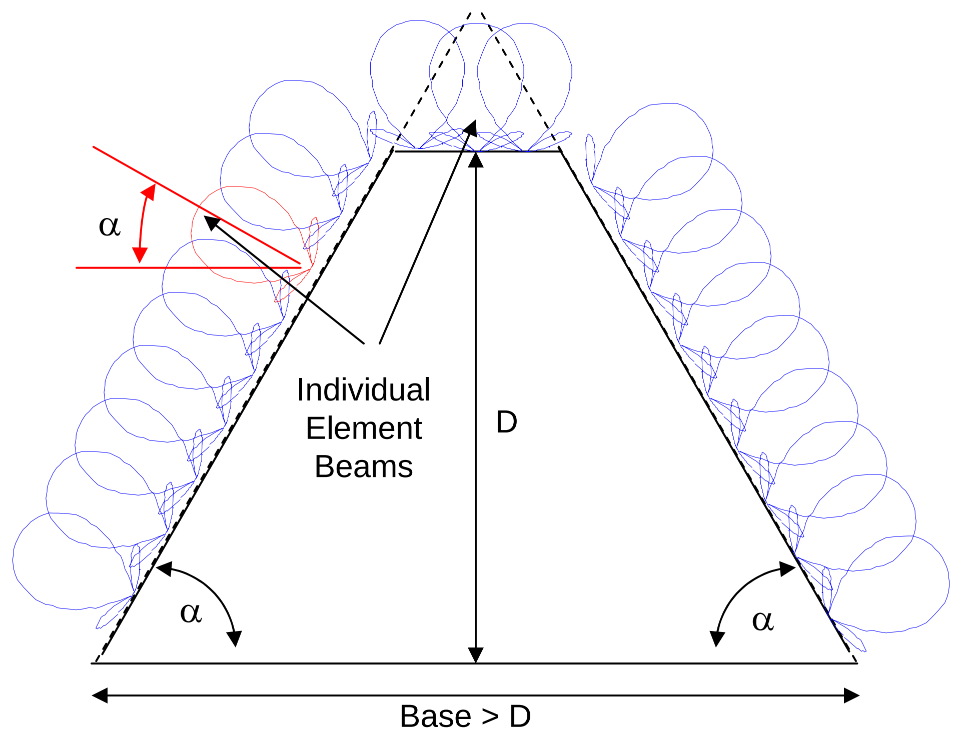
- Incorporation of two pointing mechanisms effects
  - Reliability
  - Maintainability
  - Life Cycle Cost
    - NRE
    - RE
    - Field Maintenance
  - Vibrations from gimbals not desirable in some applications
- Above issues are impetus for a solution which does not incorporate pointing mechanisms



Alternative Approach – Electronically Scanned Array

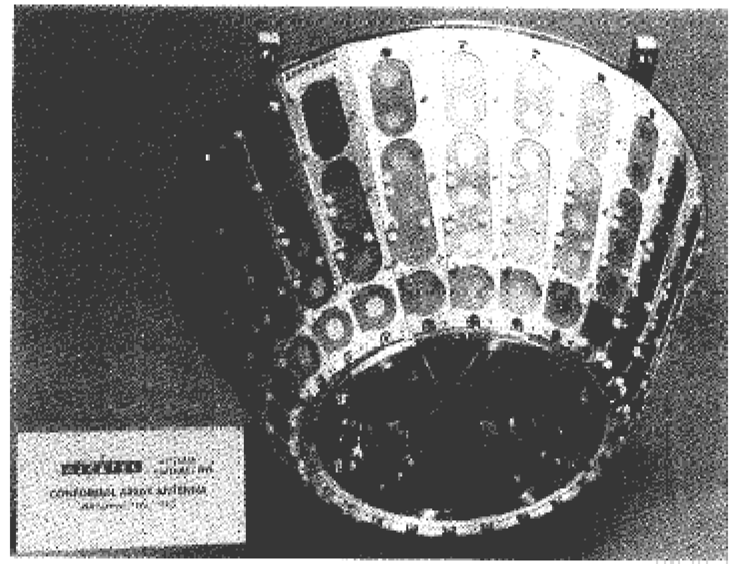
- Needs to have at least the same projected area as the reflector from all directions of the hemisphere
  - Gain is dependent on projected size
- Frustum of a cone is a good geometry for the full hemisphere
  - "a cone with it's tip chopped off"
  - May angle the top most side element some to improve crossover between side and top elements
  - A faceted cone is easier to design and manufacture than a hemispherical shape.

- Optimum alpha angle is most likely ~ 75 degrees, but is dependent on
  - Element pattern at +/- α degrees
  - Overall size
  - Beam crossovers



Recent Published Example of Similar Concept

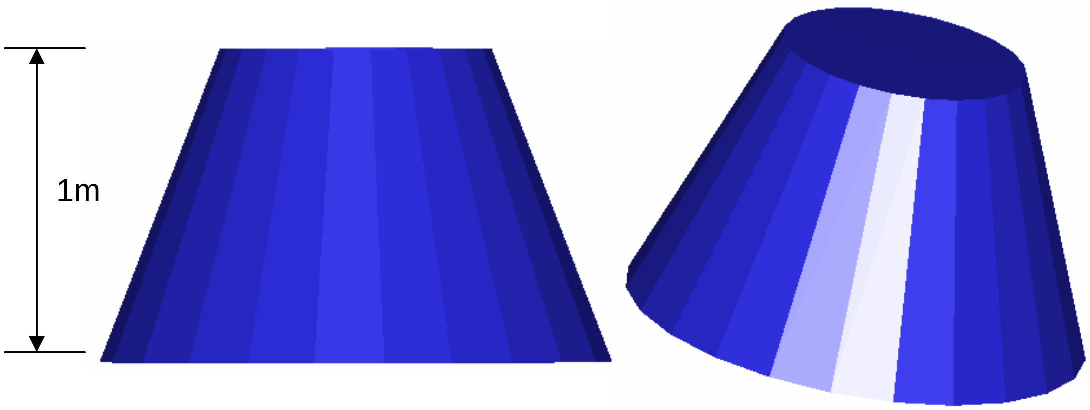
- **Space-based, X-band array for entire Earth coverage from low-Earth orbit**
  - **Polarization : RHCP**
  - **AR: < 3dB**
  - **Coverage: 360-degree azimuth, 0 to 62.3 degree elevation**
  - **Dimensions: 17.3 cm height, 37.7 cm diameter**
- **Used sightly repointed angle on top-most row**
- **Used phase shifters and Butler matrices to form the beams**



- **Taken from *Caille, G. et al, "Conformal Array Antenna for Observation Platforms in Low Earth Orbit, IEEE Antennas and Propagation Magazine, volume 44, No. 3, June 2002, pp 103-104***

Faceted Cone Frustum Tradeoffs

- **Trade-Space**
  - Overall size
  - Number of faceted sides
  - Number of elements on each facet
  - Subarray combinations on each facet
  - Beamformer complexity
  - Size, Weight, and Power (SWAP)
  - Top elements needed or left off
  - Element type
  - Sidelobes
- **H=1m**
  - Alpha=75 degrees
  - Base diameter = ~2.2m
  - Approximately the same size diameter as for the reflector case
    - <u>Phased Array does not require significantly larger base diameter than the 1 meter dish</u>



Beamformer Issues

- Depending on beam direction and beamwidth, various combinations of elements will be required
- Only a subset of all elements will be active at any one time
- Vertical facets work well as a subarray, with possibly each facet having more than one subarray
- Example of a light source near horizon shows many of the elements are not in view
  - These elements not used to form a beam in the direction of the source in this example